LACRIMATORS, STERNUTATORS AND SCREENING SMOKES

By

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Lacrimators

The lacrimators are gases commonly known as tear gases which have been used in civilian life for mob control and are used for military training purposes. They may, however, be encountered in warfare because of their immediate harassing effect on the eyes. The lacrimators, as a group, have certain well defined properties in common, the most important of which are the following:

1. They have the power to irritate certain tissues only, i.e., the eyes, and without producing noticeable lesions; their action is thus both elective and reversible since they affect only one organ, and the irritation produced quickly disappears.

2. Their threshold of action is low, i.e., they are effective in extremely low concentrations, such as a few thousandths of a milligram per liter, and can produce an intolerable atmosphere in concentrations as low as one-thousandth of that required for the most effective lethal agents.

3. They are quick acting, producing almost instantaneous physiological effects (in less than 1 minute) in the form of a muscular reaction of the eyelids, closing the eyes, and a glandular reaction from the lacrimatory glands, producing a copious flow of tears.

4. Physically, the lacrimators are, in general, liquids of relatively high boiling points and low vapor pressures. They are, therefore, essentially nonvolatile substances that form persistent gases.

A marked peculiarity of the lacrimators as a group is their relative ineffectiveness against animals. Thus it was noted early in the war that concentrations which caused profuse lacrimation in men produced no visible effect upon horses and mules. From careful tests, using brombenzyl cyanide as the agent, it was found that it was necessary to use a solution 100 times as strong to lacrimate a dog and 1,000 times as strong to lacrimate a horse

to the same degree as a man. The reason for this great difference in the sensitiveness to lacrimation between men and animals has never been satisfactorily explained, though the fact is well established by tests and war experience.

The most important lacrimators are chloracetophenone (CN), chloracetophenone solutions (CNS and CNB), and brombenzyl cyanide (CA).

Brombenzyl cyanide was the last and most powerful lacrimator used in the first World War. It was introduced by the French in July, 1918, as the culmination of their efforts to produce more powerful and effective lacrimators. It was also simultaneously adopted by the Americans as their standard lacrimator and was manufactured in the United States in the fall of 1918. Its persistency in the open is three days; in woods, seven days; and in the ground, from fifteen to thirty days. While brombenzyl cyanide was by far the most powerful lacrimator used in the last war, it has three very serious defects:

1. It corrodes iron and steel, requiring specially lined containers.

2. It is not chemically stable, but slowly decomposes in storage.

3. Its great sensitiveness to heat makes its use in artillery shell very difficult. If the bursting charge is not kept very small, it causes loss of the chemical filling through decomposition on explosion.

Chloracetophenone. Because of the difficulties attending the use of brombenzyl cyanide, the Americans toward the end of the war began to investigate the properties of chloracetophenone as a combat gas. Owing to the short time it was under study in the war and the difficulty of its manufacture, no chloracetophenone was used in World War I. Shortly after the war, however, American investigators became convinced of its superiority as a tear gas and worked out a satisfactory process of manufacture. Unlike the lacrimators used in the last war, chloracetophenone is a solid, and remarkably resistant to heat and moisture. It does not corrode metals, including iron and steel, so it may be loaded directly into shell, either by casting or pressing, without danger to the workmen handling it. In lacrimatory power, chloracetophenone is about equal to brombenzyl cyanide.

The lacrimators are classed as harassing agents, and are employed to cause temporary disability or discomfort, thus wearing down the morale and physical resistance of the enemy. By forcing the

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use of masks, they also reduce the effectiveness of hostile forces, and make sleeping and rest difficult. They may be projected by hand grenades, artillery and mortar shell, and by airplane spray or bombs, hence may be used on locations far behind the forward line as well as against forward elements. Lacrimators may be used alone as harassing agents, or in some instances, with high explosive fire to assist in demoralization.

General symptoms produced by the lacrimators include lacrimation, photophobia and blepharospasm, also some irritation of the nose and the freshly shaven face. In addition, chloracetophenone solutions CNS and CNB may cause some mild papulo-vesicular dermatitis, especially in warm weather, and occasional vomiting. Direct contact of the eyes with these solutions may cause permanent damage from corneal ulceration. These effects are more frequent and more exaggerated in warm weather and on sweaty skins.

Men who are lacrimated do not require evacuation as casualties. They only need to leave the contaminated atmosphere and face the wind, allowing it to blow into their eyes. They should not rub their eyes; their clothing and equipment should be loosened so as to get rid of entrapped gas. Bathing the eyes in cold water or with a weak boric acid or sodium bicarbonate solution will aid. If this procedure is not possible, the mask should be put on the individual and rapid breathing maintained to aid removal of the agent from the eyes, which are kept open as much as possible.

The vapor of the lacrimators produces a marked but self-limited irritation of the conjunctiva. When liquid lacrimators are splashed into the eye, the action is more corrosive and resembles the burn of a strong acid. The instillation of a solution of sodium sulfite (for eyes) at frequent intervals dissolves and neutralizes the irritating agent.

Sternutators or Irritant Smokes

By the summer of 1917, the gas masks of all of the belligerents had been developed to a stage where they furnished adequate protection against the lung-injurant gases. Also, the lung-injurant gases theretofore employed were slow acting and did not incapacitate until several hours after exposure. The problem was, therefore, to find a quick-acting nonpersistent gas that would penetrate the mask, and the sternutators or irritant smokes were the solution of the German chemists to this problem. While the sternutators produced few serious casualties, by quickly penetrating the mask, nauseating the soldier, and causing frequent vomiting, they usually made it impossible to wear the mask, and upon its removal the soldier soon fell victim to the lung-injurant agents which were fired simultaneously with the sternutators.

As a rule, the sternutators are nonlethal in concentrations ordinarily employed in battle and have the following properties in common:

1. Their thresholds of action are extremely low; a few thousandths of a milligram per liter produce certain and useful results.

2. They are immediately effective; an exposure of 1 to 2 minutes being sufficient to produce positive effects.

3. Their action is reversible, since the irritation produced disappears rapidly after termination of exposure. They do not destroy the nerve ends and, after the reflexes caused by the irritation, the nerves recuperate their normal functions.

4. Their action is elective, for they affect only the nerve tissues and especially those controlling the respiratory system.

The most important irritant smokes are Adamsite (DM) and Diphenylchlorarsine (DA). They produce sensory irritation of the nose, throat, and eyes. They may be used only in candles and hand grenades so may be employed only at close range. DM and DA are most valuable against masks with inadequate filters. Adamsite does not give a characteristic odor, but diphenylchlorarsine smells more or less like shoe polish. When not covered with a smoke screen, they may be recognized as thin clouds in the air. Like the lacrimators, it is impossible to build up a lethal concentration of the sternutators except in closed spaces.

DM and DA produce local irritation of the nose and nasal accessory sinuses, throat, and eyes. The symptoms consist of pain and a feeling of fullness in the nose and sinuses accompanied by severe headache, followed by sensations of intense burning in the throat and tightness and pain in the chest. Irritation of the eyes and lacrimation are produced. Sneezing is violent and persistent; the nasal secretion is greatly increased and quantities of ropy saliva flow from the mouth. Nausea and vomiting may also occur. Mental depression of the victim is very pronounced.

The patient should be removed from the contaminated atmosphere, kept away from heat, and his outer clothing should be removed. Flush the nose and throat with a weak solution of sodium bicarbonate or of ordinary salt. The exposed parts should be washed with soap and water. If the victim can not be removed to pure air, the mask must be worn between spells of actual vomiting and in spite of nausea and salivation. Inhalation of dilute chlorine from a small amount of bleach in a wide-mouth bottle is the most effective

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therapeutic measure. Inhalation of chloroform, ether, or alcohol vapor is less effective. Aspirin may be given to relieve the headache and general discomfort. Codeine may be strongly indicated; and if necessary, should be used early.

Screening Smokes

From a chemical warfare viewpoint, smoke is a concentration of exceedingly minute solid or liquid particles suspended in the air. Its purpose is to obscure the vision of the enemy or to screen friendly troops and terrain from enemy observation. Its mission is thus essentially defensive and in this respect is directly opposite to that of gas; for, while gas disables and kills men, smoke protects them by a sheltering mantle of obscurity. As with gas, the methodical planned use of smoke in battle was a development of World War I. History does record sporadic attempts to use smoke tactically in combat, as when, in 1700, King Charles XII of Sweden crossed the Dvina River in the face of the opposing Polish-Saxon army under the protection of a smoke screen generated by burning large quantities of damp straw. But the results of such early, isolated incidents were always too uncertain to justify the adoption of smoke as a recognized agency of warfare. The British were the first to use smoke clouds artificially generated from special apparatus so as to mask their gas attacks and lead the Germans to believe a gas attack was being put over where actually no gas was used. In such operations the British were able to advance unmasked behind the harmless smoke while the Germans, fearing gas, were put to the disadvantage of wearing masks. Smoke was also used for other deceptive purposes such as to draw wasteful artillery fire on unoccupied sectors by generating a smoke screen to indicate that an attack was imminent. The Germans soon adopted these same tactics and in turn used them effectively. By the fall of 1917, the tactical use of smoke on the Western Front had become so well established that General Pershing cabled the War Department on November 3, 1917, asking that large quantities of phosphorus be quickly manufactured for filling smoke ammunition for the American Army. Although drop bombs filled with white phosphorus were used to some extent in the World War I, the tactical employment of smoke by airplanes was not developed to any appreciable degree. On the whole, the tactical use of smoke during the last war lagged behind the tactical use of gas. It is safe to say the possibilities of the planned use of smoke in battle were only beginning to be realized at the close of the war. It is also a fact that, while the Germans took and held the initiative in the use of gas throughout World War I, the Allies excelled the Germans in the use of smoke, both from a qualitative and quantitative standpoint. This is explained by the Germans as owing to the lack of phosphorus in Germany and its availability and employment in enormous quantities by the Allies.

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From a chemical warfare viewpoint, smoke is a concentration of exceedingly minute solid or liquid particles suspended in the air. The purpose is to obscure the vision of the enemy or to screen friendly troops and aircraft from enemy observation. The majority of these are chemically inactive and on this account it directly approximates that of heavy fog, while gas disables and kills men, smoke protects them by a shielding mantle of obscurity. As with gas, the intentional tactical use of smoke in battle was a development of World War I. History does record numerous attempts to use smoke tactically in combat, as when, in 1700, King Charles XII of Sweden crossed the Dvina River in the face of an opposing Polish-Saxon army under the protection of a smoke screen generated by burning large quantities of damp straw. But the results of such early, isolated incidents were always too uncertain to justify the adoption of smoke as a recognized weapon of warfare. The British were the first to use smoke clouds deliberately generated from special apparatus so as to mask their gas attacks and lead the Germans to believe a gas attack was being made at times when actually no gas was used. In such operations the British were able to advance unmasked behind the harmless smoke while the Germans, fearing gas, were put to the disadvantage of wearing masks. Smoke was also used for other deceptive purposes such as to draw enemy fire, artillery fire or concentrated attacks by generating a smoke screen at points where no attack was intended. The Germans soon adopted these same tactics and in turn found them effective. By the fall of 1917, the tactical use of smoke on the Western Front had become so well established that General Pershing called the War Department on November 3, 1917, asking that large quantities of phosphorus be speedily manufactured for filling smoke ammunition for the American Army. Although many tanks [illegible] with white phosphorus were used for smoke screens in the World War I, the tactical employment of smoke by aircraft was not developed to any appreciable degree. On the study, the technical use of smoke during the last war lagged behind the potential use of smoke. It is safe to say the potentialities of the planned use of smoke in battle were only beginning to be realized at the close of the war. It is also a known fact that, while the Germans made full the utilization of the use of and its potential World War I, the Allies realized the importance of the use of smoke, both from a protective and offensive standpoint. This is evidenced by the invention and design of smoke weapons in Germany and its availability and [illegible] by a [illegible] production by the Allies.

The more important screening smokes are an admixture of imperfectly burned oil and water vapor, white phosphorus (WP), sulfur trioxide-chlorsulfonic acid (FS), titanium tetrachloride (FM), and HC mixture. In general, these smokes are not toxic in the ordinary field concentrations, but may be dangerous in the heavy concentrations formed at the immediate site of dispersion. The gas mask gives adequate protection against all of the screening smokes. FS smoke is more irritant and corrosive to the eyes, skin, and respiratory tract than is FM or HC. A form of chemical attack which presents great possibilities is the use of toxic smokes, DM and DA, concealed in a smoke screen.

White phosphorus creates the densest smoke per weight of the agent, is a low temperature incendiary and can produce nasty burns on personnel. It burns in the presence of oxygen; therefore, for burns with this agent immerse the affected parts in water to stop the burning of the phosphorus and pick out the solid particles from the flesh. Wet cloths may serve the purpose if immersion in water is not possible. Phosphorus melts at approximately 111°F; therefore if hot water is used, the melting particles may be removed with a cloth or sponge.

The prompt application of approximately a 10% solution of copper sulphate in water will form a thin coating of copper phosphides on the phosphorus particles, which will stop their burning at once. The coated particles can then be picked out of the flesh. The copper sulphate solution should be applied by soaking a pledget of cotton, a sponge, or a piece of cloth in the solution and then placing it on the phosphorus. A minute or two is sufficient time for the formation of the metallic covering coat. After removal of the phosphorus, the burns should be dressed. All severe cases should be evacuated.

Liquid titanium tetrachloride (FM) produces acid-like burns of the skin and eyes. The smoke generated by the liquid FM is unpleasant to breathe and may cause some irritation of the nose and throat, but it is not dangerous. However, exposure of the eyes to spray will cause conjunctivitis with lacrimation and photophobia. Acid skin burns are produced by contact with the liquid. The eyes or skin should be washed freely with water and then with two percent sodium bicarbonate solution.

Sulfur trioxide chlorsulfonic acid solution (FS) in liquid form produces acid burns of skin or mucous membranes upon contact. The symptoms are usually limited to an irritation of the skin, manifested by a biting and prickling sensation. The treatment of eye burns from liquid FS is most important. Irrigation with water should be instituted at once and continued for half an hour, followed by repeated flushing with 2% sodium bicarbonate solution for

The more important screening smokes are as mixtures of light heated oil and water vapor, white phosphorus (WP), sulfur trioxide-chlorsulfonic acid (FS), titanium tetrachloride (FM), and HC mixture. In general, these smokes are not toxic in the ordinarily field concentrations, but may be dangerous in the heavy concentrations formed in the immediate area of shell-burst. The gas mask gives adequate protection against all of the preceding smokes. FS smoke is more irritant and corrosive to the eyes, skin, and respiratory tract than is FM or HC. A form of chemical attack which presented great possibilities is the use of toxic smokes, DM and DA, concealed in a smoke screen.

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3 to 4 hours. Upon completion of this treatment a small amount of 2% aqueous mercurochrome solution should be dropped in the eye to detect possible corneal ulceration. If painful, 2% butyn may be instilled. Cod liver oil ointment or castor oil or yellow oxide of mercury ointment should then be instilled and the injured area covered with a light pad. Skin burns should first be washed with water and then with sodium bicarbonate solution; later treatment should be that of ordinary burns.

HC Mixture produces no symptoms other than a slight suffocating sensation from high concentrations of the smoke. Therefore no treatment is needed.